The Evolution Process of Warm Season Intense Regional Rainfall Events in Yaan

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Background

- Despite the steady improvement in predicting precipitation, the skill associated with warm season heavy rainfall prediction remains low.
- Although the accuracy of numerical models has increased in the past several decades, long-term bias still exists in the precipitation simulations within complex terrain.
- Therefore, there is the need to better understand the physical processes of how complex terrain impact rainfall by using observations.
- Located on the eastern periphery of the Tibetan Plateau (EPTP), one of the typical areas with complex terrain, Yaan “rain city” has the maximum annual precipitation amount and rainy days within inland China. Yaan thus becomes an ideal place for studying rainfall and its interaction with complex orography.

Objectives

- Determine the evolution process of Yaan intense precipitation
- Figure out how does the multiscale circulations and topography interact with each other to create the process.

Materials and Methods

- Hourly rain gauge records from NMIC, CMA, and SMB: 2009-2016

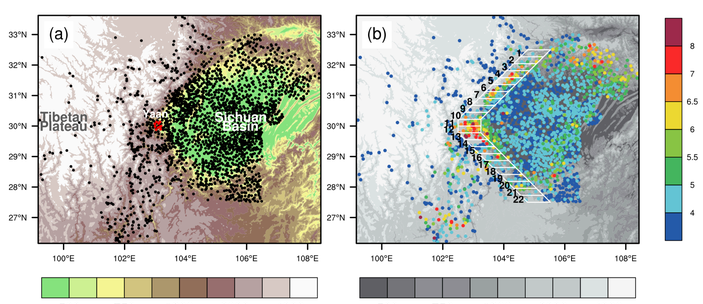

Fig.1 Stations used in this study (a) and the multi-year average of daily precipitation amount (mm d^{-1}).

- ERA-Interim reanalysis from ECMWF: 6-hr, 0.75°*0.75°, 27 vertical levels
- Regional Rainfall Events (RREs)

Evolution process of intense RREs

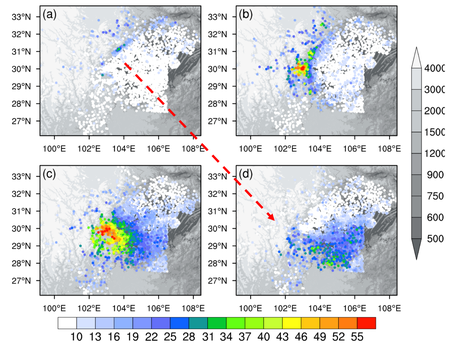

Fig.2 Average rainfall frequency (unit: %) in the four periods of RREs.

- A clear progression of north to south movement of the rainfall amount (frequency) is found along the EPTP.

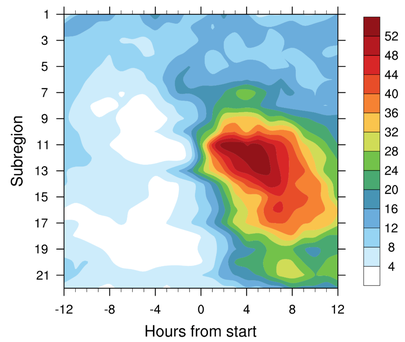

Fig.3 Rainfall amount (unit: mm h-1) averaged in each of the 22 subregions at 12 h around the start time of the RREs.

Corresponding circulations

- High-level circulations favor the evolution of rainfall

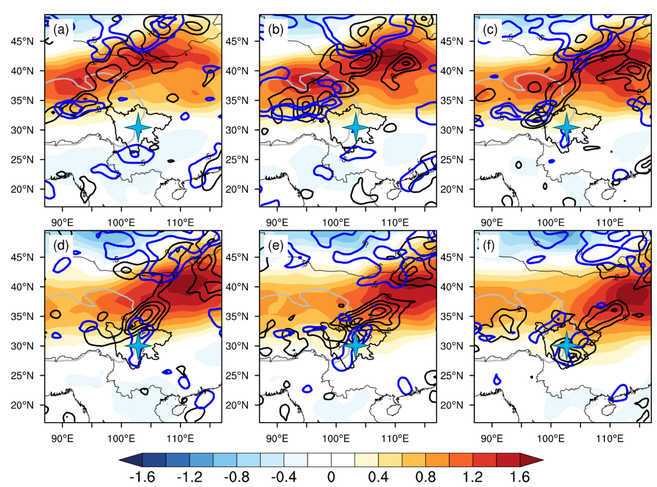

Fig.4 Anomalous temperature at 300 hPa (shaded, unit: K), divergence at 200 hPa (black contour) and relative vorticity at 500 hPa at different time steps.

- Low-level circulations also show north to south propagations

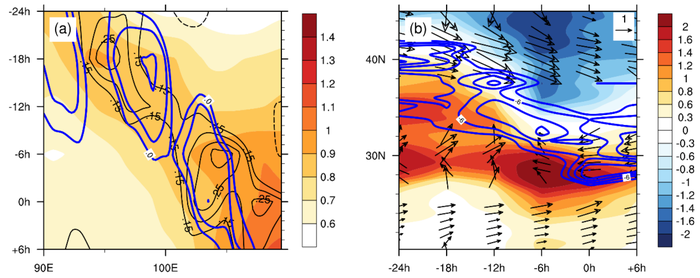

Fig.5 (a) Hovmueller plot for anomalous temperature at 300 hPa (shaded) , divergence at 200 hPa and relative vorticity at 500 hPa averaged between 30°N and 40°N; (b) the temporal evolution of anomalous surface temperature (shaded), 700hPa vertical velocity and 850 hPa horizontal winds (vector) at different latitudes averaged between 103°E and 105°E.

- Slope-perpendicular component of low-level winds matches well with the rainfall evolution process

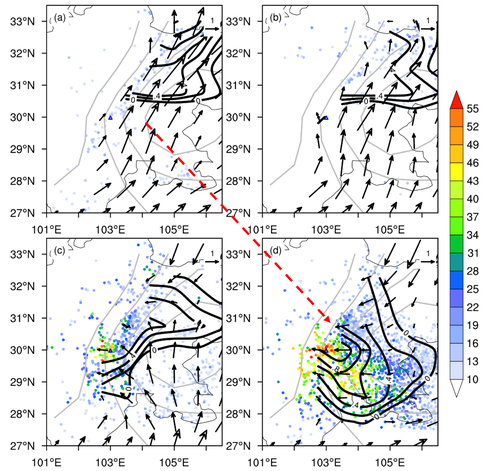

Fig.6 Winds at 750 hPa (vector) and their perpendicular component toward terrain (contour), and precipitation frequency (color dots) at -12 h, -6 h, 0 h, and +6 h.

Conclusions

- During the Yaan intense rainfall events, a clear progression of north to south movement of the rainfall amount (frequency) is found along the EPTP.
- The evolution of the Yaan intense rainfall process is closely related to the intrusion of the anomalous low-level wind associated with the surface low pressure center and the middle level trough of the synoptic scale wave.